CHAPTER FORTY

Team Coordination

David W. Eccles, Durham University, UK

Please address correspondence to David W. Eccles, Sport Programme, School of Applied Social Sciences, Durham University, 42 Old Elvet, Durham, DH1 3HN, UK. Phone: +44 (0)191 334 6995. Fax: +44 (0)191 334 6821. Email: d.w.eccles@durham.ac.uk. The author would like to acknowledge the kind contributions to this chapter made by Kate Petty and Joel Stewart, students in the Sport, Exercise, and Physical Activity undergraduate programme at Durham University.

Introduction

Who can fail to be impressed by a midfield player's beautifully timed pass of the soccer ball to a striker sprinting into the box; or by an under-pressure quarterback's ability to complete a pass to a receiver through a tiny window in the opponent's defense? One reason we enjoy team sports, either because we play in a team or observe one as a fan, is the potential for the team to exhibit excellent coordination. Within sport psychology, however, there has been little research into understanding how teams achieve coordination. Sport psychologists have instead concentrated on understanding teams from a social perspective (e.g., Burke, Davies, & Carron, 2014). Cognitive sport psychology has provided insights concerning skilled sports performance (e.g., Williams, Ford, Eccles, & Ward, 2011) but the unit of analysis within this field is the individual, even when the focus is skilled performance by members of teams. Nonetheless, researchers have recently taken an interest in team coordination (e.g., Eccles & Tran Turner, 2014). The aim here is to review their work to provide direction for future research in this area and help identify coaching and practice activities that can enhance team coordination.

The chapter begins with definitions of team coordination. Next, an explanation is provided of why team coordination is required. A social–cognitive team-level explanation of how coordination can be achieved is then proposed. The chapter ends with a discussion of the applied implications of the framework described here and proposals for future research directions.

Theory and Research on Team Coordination

Within this section, the concepts discussed are based on the work of Eccles and his colleagues (Eccles, 2010; Eccles & Tenenbaum, 2004, 2007; Eccles & Tran Turner, 2014). The section begins with definitions of team coordination.

Definitions of Team Coordination

Coordination can be defined as arranging team members' actions so that, when they are combined, they are in suitable relation for the most effective result. Within the definition, the term "relation" concerns three dimensions of action: type, timing, and location. Coordination involves arranging team members' actions so the correct type of action(s) is performed at the correct time(s) and location(s). Achieving a team action may require members to each undertake a specific action. For example, in a rugby lineout, in order for one player to catch the ball other players must lift the catching player into the correct position. Achieving a team action may also require team members to each undertake an action at a specific time. In volleyball, a ball delivered at the wrong time by the setter will result in a relatively ineffective strike by the hitters. Achieving a team action also may require team members to each undertake an action at a specific location. In a 100 m relay race, the athlete receiving the baton must ensure they are positioned to receive it in the changeover zone. Ideally, the baton exchange should occur at the latest point in this zone to allow the outgoing athlete maximum acceleration. Exchanging the baton in the middle of the zone prevents the outgoing athlete from fully utilizing the acceleration space.

The Requirement for Team Coordination

In this section, there is an attempt to address why achieving coordination is challenging. When an individual performs a task, even when the task involves multiple actions (e.g., in a pole vault), arranging these actions is simple relative to a situation in which tasks are completed by a team. For the individual, there are inherent constraints on action: An individual cannot be in more than one location at once and has difficulty executing more than one physical action simultaneously. By contrast, a team's constituent members can be in as many different locations, and performing as many different actions, as there are team members. Furthermore, for an individual, the task has one controlling entity, which is the brain. For the team, there are as many controlling entities as there are team members. Each

individual team member can function independently and pursue personal goals, and has unique knowledge of how to perform a given task. Without an attempt to coordinate the actions of individuals placed into a team, team members can (and tend to) independently select the type, timing, and location of their actions. However, team members cannot select actions at their own discretion if the team's performance is to be successful because the action(s) undertaken by one team member must be related in terms of action type, timing, and location to actions undertaken by other team members. There is a striking effect on a team's performance if one team member fails to execute the assigned task. For example, in American football, if the left tackle fails to protect the quarterback, the quarterback is unlikely to make a pass before getting sacked.

Team performance is affected by the requirement to coordinate team members' actions. For inexperienced teams particularly, a team's overall performance tends to be superior to that of any individual within the team but is often less than the sum of the individual performances of the team members (Comrey, 1953). These losses in per person productivity as team size is increased are termed *process losses* (Steiner, 1972). Early evidence of process losses were provided in studies by Ringelmann (1913) of teams undertaking agricultural tasks (Kravitz & Martin, 1986). Ringelmann revealed that contributions by individual team members to the tasks decreased with each additional team member. On a rope-pulling task, there was no increase in force exerted on the rope when more than seven individuals were assigned to pull the rope. Contemporary studies, including a study of a sports team, have provided similar results (Comrey; Widmeyer, Brawley, & Carron, 1990). There are various explanations for process losses (Eccles & Tran Turner, 2014) but the focus here is on *coordination losses*. For example, Ringelmann attributed the process loss observed for the rope pulling task to a lack of simultaneity of the muscular contractions of the individuals within the pulling team.

A Social-Cognitive Explanation of How Team Coordination is Achieved

Several cognitive mechanisms have been proposed as mediators of an individual athlete's performance (Ward & Eccles, 2006), which can form the basis for understanding how team coordination is achieved. With accumulated experience and practice in a given sport, there is an increase in the amount and organization of domain-specific information (e.g., tactical knowledge) an athlete possesses. There are also changes in the athlete's long-term memory for domain-specific information. Memory structures are developed that enhance storage in, and retrieval from, long-term memory for domain-specific information. These structures support the integration of information from the current task environment (e.g., the score) with previously acquired domain-specific information. This allows the athlete to construct, and update during the performance of a task, an elaborate mental representation of the current task situation and possible future changes to this situation. The long-term memory structures also support the activation within this representation of various response options (i.e., actions) appropriate to resolving the current task situation and possible future task situations. Hence, the construction and updating of this representation enhances the athlete's ability to anticipate changes in the task environment (including changes in teammates' actions) and to select, prepare, and execute appropriate responses to these changes so that coordination can be achieved.

Thus, a consideration of the cognitive mechanisms underpinning an individual athlete's activity appears necessary for understanding how teams achieve coordination. However, these individual-level mechanisms do not appear sufficient to explain the team-level concept of team coordination. Another concept requires consideration but this concept has been overlooked within studies of skilled performance in team sports because, as stated above, the individual has been the unit of analysis in these studies. This concept is a shared knowledge state. To elaborate, team coordination depends on a psychological state being

reached in which each team member's understanding (i.e., representation) of the situation is at least similar to other team members' understandings of the situation (Eccles & Tenenbaum, 2004). As proposed above, when individuals within a team have a unique knowledge of how to perform a given task, function independently, and pursue personal rather than collective goals, team coordination is typically poor. However, when each team member has a similar (i.e., shares) knowledge of how the team and its constituent members will perform the task, all team members can draw on that same knowledge to perform the task, which enhances team coordination. Two types of shared knowledge that underpin team coordination are discussed below; the first is established *prior to* a given game and the second is established and updated *during* a given game.

Shared Knowledge States Established Prior to a Game. Prior to a given game, teams acquire a shared knowledge state concerning how the team and its constituent members will perform their tasks via two means. The first means involves practice- and competition-based play and the second means involves explicit planning. Shared knowledge acquired through play comprises knowledge of "situational probabilities", which concern what actions the team and its individual members are likely to undertake in response to a given game situation. Team members come to share knowledge of situational probabilities by playing (a) the sport generally and (b) on a particular team.

Regarding playing the sport generally, players learn from practicing and competing within their sport what teams and individual team members *in general* are likely to do in a given situation. Consider a newly formed soccer team where, previously, every team member has played the sport but no team member has played on this particular team. As a result of their experience playing the sport, all the players on this team know that when a midfield player on their team accidentally turns the ball over to the opposition, team members are

likely to respond to the turnover by moving back towards their own goal into a defending position.

On many well-established teams, players come to know through playing with each other what their team and its individual team members are likely to do in a given situation. Consider how team members playing on the same volleyball team for several years would learn that the setter always gives the ball to a backcourt player to hit when the setter is out of position and drawn away from the net due to a poor serve-receive pass. Coaches often design practice drills (e.g., "2 v 1s" in soccer) and scrimmages to accelerate players' learning of situational probabilities related to their team and individual teammates. Coaches place players in prototypical game situations that require them to coordinate with their teammates so players learn how those situations "play out".

The distinction between shared knowledge acquired via experience of playing the sport and via experience of playing on a particular team has received recent empirical support in a study of tennis doubles (Blickensderfer, Reynolds, Salas, & Cannon-Bowers, 2010). While the space afforded here does not permit a detailed discussion of the study, evidence was provided in the study that shared knowledge is important for team coordination; and that team members come to share knowledge with other team members by playing the sport generally *and* playing on that particular team.

As highlighted above, shared knowledge is also acquired prior to a given game via explicit planning. Coaches often provide information about the team's intended actions to team members by communicating plans of action to those members. Coaches will often communicate a plan by presenting the plan (e.g., a play) verbally and sometimes graphically (e.g., via a whiteboard) during a team meeting and then by having the team practice executing the plan (e.g., running the play) on the field. Planning can take place at different levels of team functioning (cf. Hayes-Roth & Hayes-Roth, 1979). At the most general level, outcomes

constitute the desired accomplishments of the team such as “win by two goals”. Planning at this level involves a decision, termed an intention, about which outcome(s) to pursue. At the next lower level, designs relate to the general behavioral approach taken to achieve an outcome such as “aggressive play” and the decision about which design(s) to employ is termed a scheme. Next, procedures constitute specific sequences of gross actions such as “attack down the right wing”. Planning at this level involves a decision, termed a strategy, about which procedure(s) to employ. At the lowest level, operations constitute micro-level actions such as “Player A should attempt, whenever possible, to pass to Player B”. A decision at this level about which operation(s) to employ is termed a tactic. While planning can occur at any level of abstraction, plans involving only higher levels place few constraints on how that plan might be implemented at lower levels. For example, the design of “slowing the game down” in soccer provides few specific constraints on players’ moment-to-moment selections at the operational level during the game, affording players flexibility in the use of tactics to slow the game down.

The result of (a) playing the sport generally, (b) playing in a particular team within the sport, and (c) creating and practicing the execution of team plans is a relatively established, stable form of shared knowledge. This state is achieved prior to a given game and forms a cognitive resource that team members can utilize during a given game to achieve coordination. Consider an example of a defensive block in volleyball. The movements and actions of the players are planned by a coach and then discussed with the players. The play is then drawn on a whiteboard and team members watch a video showing the play being executed by another team. Next, the players rehearse the play during practice, first without hitters to block and then with hitters. The coach provides feedback and players practice the skill until they feel comfortable executing it. At this point, each player involved in the play knows: (a) when to use the play; (b) what actions those involved in the play are expected to

perform; and (c) how his/her own actions fit with the actions of teammates. Consequently, the play can be used during actual games.

Shared Knowledge States Established During a Game. Additional to the shared knowledge states obtained prior to a game, a dynamic form of a shared knowledge state about the team's intended actions is established and updated by a team *during* a game. This "in-game" state is necessary because games in team sports are dynamic and changes to game situations are difficult to predict (e.g., interceptions in American football). Teams often switch strategies according to these changes. When a change occurs and a team begins to adopt a different strategy in response to this change, a challenge is that team members must come to know that the strategy has changed; that is, the team must update its in-game shared knowledge state. Consider a soccer team that has obtained a shared knowledge state prior to the game about two defensive strategies: (a) press the opponent high up the field to regain possession quickly; and (b) stand off the opponent and defend from deep to contain their attacks. The team then prepares to play an opponent and, by scouting the opponent, identifies that the opponent often loses the ball when pressed high up the field. A game plan is made to press the opponent high up the field when they have the ball. Thus, an *initial* in-game shared knowledge state is established. When the game begins, the team soon realizes that, contrary to expectations, the opponent retains possession quite effectively when pressed. Given this change, the team wants to switch their defensive strategy to standing off the opponent and defending from deep to contain their attacks. For this to occur, team members need to know the change is happening; that is, the team's in-game shared knowledge state needs updating.

Updating can occur via incidental and deliberate means. In terms of incidental means, one or two team members may respond to a change in the game situation by beginning to adopt a strategy different to the one they had been following. Returning to the soccer example, the realization that the opponent is actually effective at keeping possession when

pressed may lead to one or two midfield players to stop pressing and drop deeper towards their defensive line. When other team members see these changes to their teammates' actions, they may infer that the current strategy is being abandoned and a different strategy is being adopted. Note here that inferences of this type are more accurate when the team has a shared knowledge, achieved *prior to* the game, of the range of strategies available to the team. While the soccer team began to defend by pressing high up the field, team members also shared knowledge, prior to the game, of the defending-from-deep strategy. Consequently, during the game, they are able to recognize their teammates beginning to adopt a deeper defensive strategy when their attempts to win the ball high up the field prove fruitless.

As proposed above, in-game shared knowledge states are also updated via the deliberate communication, both verbal (e.g., shouts) and non-verbal (e.g., pointing), of intended changes to upcoming actions between team members (including coaches). Team members are able to adopt the strategy being communicated by drawing on their shared knowledge, achieved *prior to* the game, of the range of strategies used by the team. Evidence of this process has been provided in studies of basketball (Bourbousson, Poizat, Saury, & Seve, 2010), doubles tennis (Lausic, Tenenbaum, Eccles, Jeong, & Johnson, 2009), and table tennis (Poizat, Bourbousson, Saury, & Sève, 2012). Within the study by Bourbousson et al., researchers filmed a basketball game and asked each of the five members of one of the teams to view film of each play within a section of the game and describe his activity during that play. For each play, each player's verbal response was analyzed to determine which (and how many) teammates were considered by that player in relation to his intended actions during the play. Players most frequently (49%) considered only one other player and one player in particular, named "Chris". Further analysis revealed that during offensive play, Chris' main responsibility was to communicate (verbally or by gesture) to his teammates the play they were to use.

Applied Implications

Presented here are a few considerations for applied implications of the theory and research on coordination; a more expansive range of considerations, see Eccles and Tran (2012) and Eccles and Tran Turner (2014). A key method of enhancing a team's ability to achieve a shared knowledge state prior to, and during games is to enhance communication between team members. One approach to enhancing communication prior to a game involves aiming for "anywhere, anytime" learning by offering a representation of game plan information that lasts longer than the typical verbal presentation of the plan by a coach. An example would include providing players with handouts of positioning and structure. During games, time for planning and changing plans is limited and communication about plans can be difficult (e.g., due to noise). One strategy for improving verbal communication between two team members during a game involves ensuring there are three exchanges between the members, where the third exchange "closes the loop": (a) Player A sends the message ("Mark number four"); (b) Player B acknowledges the message ("Ok, I'm on player four"); (c) Player A acknowledges the confirmation, showing his awareness that Player B understands the message ("You're marking four, keep it up").

Directions for Future Research

An understanding of the team coordination will be advanced using two complementary lines of research. First, the methods used by skilled teams to achieve coordination need to be identified to generate "expert models" of the coordination process (Eccles, Ward, & Woodman, 2009), which can provide a principled basis for the design of practice regimens aimed at enhancing the performance of less-skilled teams. Two research approaches could be used to this end. First, following Lausic et al. (2009), measures of the coordination process could be developed and, under controlled conditions, low- and high-performance teams could be compared on these measures. Second, field approaches,

including observation, measures of behavior, and interviews, might be used to obtain in-depth "contextual descriptions" of real attempts by skilled teams to achieve coordination. Field approaches such as these have been used in industrial domains where there is an understanding that, within human-machine systems, certain types of error, including coordination breakdowns, cannot be understood without studying whole systems in context (Hutchins, 1995). A second future research direction involves experimental tests of specific hypotheses derived from the framework proposed here. The literature does not contain tests of basic research questions concerned with the extent to which knowledge of a team's intended actions needs to be shared for coordination to be achieved. One model for such research includes examinations of group coordination within social psychology (Abele & Stasser, 2008).

Conclusion

In this chapter, we considered why team coordination is required and why it is difficult to achieve. Team-level social-cognitive states, such as shared knowledge states, and processes, such as communication, required to achieve coordination were then considered. We then presented implications of this framework for enhancing coordination in sports teams and offered directions for future research in this area. The continued study of the emerging topic of coordination will enhance our understanding of team functioning in sport.

References

Abele, S., & Stasser, G. (2008). Coordination success and interpersonal perceptions: Matching versus mismatching. *Journal of Personality and Social Psychology, 95,* 576-592. doi:10.1037/0022-3514.95.3.576

Blickensderfer, E. L., Reynolds, R., Salas, E., & Cannon-Bowers, J. A. (2010). Shared expectations and implicit coordination in tennis doubles teams. *Journal of Applied Sport Psychology, 22,* 486-499. doi:10.1080/10413200.2010.507497

Bourbousson, J., Poizat, G., Saury, J., & Seve, C. (2010). Team coordination in basketball: description of the cognitive connections among teammates. *Journal of Applied Sport Psychology, 22,* 150-166. doi:10.1080/10413201003664657

Burke, S. M., Davies, K. M., & Carron, A. V. (2014). Group cohesion in sport and exercise settings. In In M. Beauchamp and M. Eys (Eds.), *Group dynamics in exercise and sport psychology: Contemporary themes* (2nd ed., pp. 147-163). London, UK: Routledge.

Comrey, A. L. (1953). Group performance in a manual dexterity task. *Journal of Applied Psychology, 37,* 207-210. doi:10.1037/h0061036

Eccles, D. W. (2010). The coordination of labour in sports teams. *International Review of Sport Exercise Psychology,* 3, 154–170. doi:10.1080/1750984X.2010.519400

Eccles, D. W., & Tenenbaum, G. (2004). Why an expert team is more than a team of experts: a cognitive conceptualization of team coordination and communication in sport. *Journal of Sport and Exercise Psychology, 26,* 542–560.

Eccles, D. W., & Tenenbaum, G. (2007). A social cognitive perspective on team functioning in sport. In G. Tenenbaum & R. C. Eklund (Eds.). *Handbook of sport psychology* (3rd ed., pp. 264-283). New York, NY: Wiley. doi:10.1002/9781118270011.ch12

Eccles, D. W., & Tran, K. (2012). Getting them on the same page: Strategies for enhancing coordination and communication in sports teams. *Journal of Sport Psychology in Action, 3,* 1-10. doi:10.1080/21520704.2011.649229

Eccles, D. W., & Tran Turner, K. (2014). Coordination in sports teams. In M. Beauchamp and M. Eys (Eds.), *Group dynamics in exercise and sport psychology: Contemporary themes* (2nd ed., pp. 240-255). London, UK: Routledge.

Eccles, D. W., Ward, P., & Woodman, T. (2009). The role of competition-specific preparation in expert sport performance. *Psychology of Sport and Exercise, 10,* 96-107.

Hayes-Roth, B., & Hayes-Roth, F. (1979). A cognitive model of planning. *Cognitive Science, 3,* 275-310. doi:10.1207/s15516709cog0304_1

Hutchins, E. (1995). *Cognition in the wild.* Cambridge, MA: MIT Press.

Kravitz, D. A., & Martin, B. (1986). Ringlemann rediscovered: The original article. *Journal of Personality and Social Psychology, 50,* 936-941.

Lausic, D., Tenenbaum, G., Eccles, D. W., Jeong, A., & Johnson, T. (2009). Intra-team communication and performance in doubles tennis. *Research Quarterly for Exercise and Sport, 80,* 281-290.

Poizat, G., Bourbousson, J., Saury, J., & Sève C. (2012). Understanding team coordination in doubles table tennis: joint analysis of first- and third-person data. *Psychology of Sport and Exercise, 13,* 630-639.

Ringelmann, M. (1913). Recherches sur les moeurs animés: Travail de l'homme [Research on animate sources of power: The work of man]. *Annales de l'Institute National Agronomique, 2e série-tome XII,* 1-40.

Steiner, I. D. (1972). *Group process and productivity.* New York, NY: Academic Press.

Ward, P., & Eccles, D. W. (2006). A commentary on "Team cognition and expert teams: emerging insights into learning and performance for exceptional teams." *International Journal of Sport Exercise Psychology, 4,* 463-483.

Widmeyer, W. N., Brawley, L. R., & Carron, A. V. (1990). The effects of group size in sport. *Journal of Sport & Exercise Psychology, 12,* 177-190.

Williams, A. M., Ford, P., Eccles, D. W., & Ward, P. (2011). Perceptual-cognitive expertise in sport and its acquisition: implications for applied cognitive psychology. *Applied Cognitive Psychology, 25,* 432-442. doi:10.1002/acp.1710